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Washington State Building Codes Council
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RE: Health Evidence in Support of Ventilation proposals 21-GP2-062 and 21-GP2-063

Burning fossil fuels in buildings degrades both indoor and outdoor air quality, in addition to posing a clear health risk to the public. Multiple peer-reviewed studies over the last several decades have demonstrated overwhelming evidence that gas stoves are a source of indoor air pollution, which increases the risk and severity of respiratory illnesses like asthma in children – a health risk much higher in homes with gas stoves than homes with electric stoves.[1,2,3]

As such, we are writing to express our support for the following proposed code changes included within the CR-102 filing for the International Mechanical Code: Differentiated Ventilation Proposals 21-GP2-062 and 21-GP2-063

This letter addresses the following points:

1) Gas stoves release unique pollutants beyond those from electric stoves
2) A robust body of evidence demonstrates the link between gas stoves and health impacts
3) The health evidence cannot be ignored in the building code process
4) There is precedent for strengthening ventilation requirements based on health and science

[1] Belanger K et al., *Association of indoor nitrogen dioxide exposure with respiratory symptoms in children with asthma.* AM J RESPIR CRIT CARE MED (2006), available at https://www.atsjournals.org/doi/full/10.1164/rccm.200408-1123OC.
[2] J. D. Spengler et al., "Nitrogen Dioxide and Respiratory Illness in Children. Part IV: Effects of Housing and Meteorologic Factors on Indoor Nitrogen Dioxide Concentrations," *Research Report (Health Effects Institute)* 58 (December 1, 1996): 1–29; discussion 31-36, https://pubmed.ncbi.nlm.nih.gov/9063844/.
[3] N. A. Mullen et al., "Results of the California Healthy Homes Indoor Air Quality Study of 2011-2013: Impact of Natural Gas Appliances on Air Pollutant Concentrations," *Indoor Air* 26, no. 2 (March 17, 2015): 231–45, https://doi.org/10.1111/ina.12190.

1) Gas Stoves Release Unique Pollutants Beyond Those from Electric Stoves

Gas stoves present a unique and dangerous human health threat due to combustion of a methane-based fuel inside buildings. Gas stove combustion produces *additional* particulate matter (PM) beyond that which is emitted from cooking, as well as nitrogen dioxide (NO_2) and carbon monoxide.[4] Peer-reviewed studies show that gas stoves often produce pollution levels indoors that can exceed thresholds designed to protect health, including the national ambient air quality standards' (NAAQS) relatively lenient 100 ppb standard for NO_2.[5,6]

Because electric stoves do not combust fuels directly, they emit much lower or zero levels of these pollutants. Plus, unlike other gas appliances that are required to vent outside because of known health risks, gas stoves may vent indoors making them even more dangerous.[7] While replacing gas stoves with electric stoves altogether will eliminate unnecessary exposure to NO_2 and other harmful pollutants caused by gas stove combustion, establishing more stringent ventilation standards for gas stoves is a health-protective step worth pursuing.

2) A robust body of evidence shows the link between gas stoves and health impacts

The scientific consensus that gas stoves harm human health is robust and growing ever stronger. The clear relationship between gas stoves, increased NO_2 levels in homes, and increased incidence of asthma is thoroughly detailed in peer-reviewed literature.[8,9,10,11] Gas cooking is a main predictor of indoor NO_2

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[4] Peter Strait, California Energy Commission, Sept. 30, 2020 Presentation Slide 11. Link: https://efiling.energy.ca.gov/GetDocument.aspx?tn=234999&DocumentContentId=67873

[5] *See, e.g.*, Laura M Paulin et al., 24-h Nitrogen dioxide concentration is associated with cooking behaviors and an increase in rescue medication use in children with asthma. Environ Res. 2017 Nov;159:118-123., p 6, doi: 10.1016/j.envres.2017.07.052 (finding that the use of a gas stove for 2 hours may increase 24-hour indoor NO_2 concentrations to levels close to 200 ppb, a value above both the annual and 1-hour EPA ambient limits and World Health Organization recommended indoor air guidelines).

[6] Jennifer Logue et al., "Supplemental Material Pollutant Exposures from Natural Gas Cooking Burners: A Simulation-Based Assessment for Southern California," *Environmental Health Perspectives*, January 1, 2014, https://ehp.niehs.nih.gov/doi/suppl/10.1289/ehp.1306673 (also finding that 1.7 million Californians may routinely be exposed to carbon monoxide levels that exceed federal standards).

[7] International Code Council, "2018 INTERNATIONAL FUEL GAS CODE – ICC DIGITAL CODES," codes.iccsafe.org, August 2017, https://codes.iccsafe.org/content/IFGC2018.

[8] Kathleen Belanger et al., "Household Levels of Nitrogen Dioxide and Pediatric Asthma Severity," *Epidemiology* 24, no. 2 (March 2013): 320–30, https://doi.org/10.1097/ede.0b013e318280e2ac.

[9] Hansel NN, Breysse PN, McCormack MC, et al. A longitudinal study of indoor nitrogen dioxide levels and respiratory symptoms in inner-city children with asthma. *Environmental Health Perspectives.* 2008;116(10):1428-1432.

[10] W. Lin, B. Brunekreef, and U. Gehring, "Meta-Analysis of the Effects of Indoor Nitrogen Dioxide and Gas Cooking on Asthma and Wheeze in Children," *International Journal of Epidemiology* 42, no. 6 (August 20, 2013): 1724–37, https://doi.org/10.1093/ije/dyt150.

[11] Downen S R, Dong Q, Chorvinsky E, et al. Personal NO2 sensor demonstrates feasibility of in-home exposure measurements for pediatric asthma research and management. *J Expo Sci Environ Epidemiol*. 2022;32(2):312-319, https://www.nature.com/articles/s41370-022-00413-0.

concentrations; therefore, it is often used as a proxy for indoor NO_2 exposure.[12] Gas stoves have been found to frequently produce indoor concentrations of nitrogen dioxide (NO_2) that exceed health-based standards, not only at a peak level but also at time-averaged levels.[13] The relationship between NO_2 exposure and childhood asthma is in fact well-documented in recent peer-reviewed literature, with federal agencies contributing to this growing body of research.[14]

In the 2008 longitudinal study by Hansel et al. conducted in the homes of 150 children with asthma, the presence of a gas stove was independently associated with higher NO_2 concentrations in the homes of 150 children, and increases in NO_2 exposure were associated significantly with an increase in the number of days with respiratory symptoms, after adjustment for potential confounders.[15]

The 2013 comprehensive Lin et al. meta-analysis reviewed 36 years of research and found that children living in homes with a gas stove are 42% more likely to experience asthma symptoms and 24% more likely to be diagnosed with asthma by a doctor compared to those living in homes with electric stoves.[16]

Studies that incorporate in-home NO_2 measurements consistently find a strong link between NO_2 exposure and respiratory health effects. For example, Belanger et al 2013 is a key epidemiological study, a yearlong large prospectus study of 1,342 asthmatic children including four in-home NO_2 measurement periods.[17] That direct measurement study found that that when asthmatic children were exposed to low levels of NO_2 concentrations (as low as 11 ppb), their asthma got worse. A 2022 study equipped pediatric asthma patients with home-based NO_2 sensors, and found that patients living in homes with gas stoves had higher frequencies of acute NO_2 exposures than patients without gas stoves, and that acute exposures were positively correlated with hospital admissions.[18]

As for NO_2, in 2016, the EPA made the conclusive finding that short-term exposure to nitrogen dioxide has a causal relationship to respiratory effects, including the development of asthma.[19] The table below from EPA's 2016 Integrated Science Assessment for nitrogen dioxide shows strengthening evidence of NO_2's effect on the body, including a causal relationship between short-term exposure to NO_2 and

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[12] Brett Singer, Lawrence Berkeley National Lab, Sept. 30, 2020 Presentation Slide 7 (citing N.A. Mullen et al., *Results of the California Healthy Homes Indoor Air Quality Study of 2011-13: Impact of Natural Gas Appliances on Air Pollutant Concentrations*, 26 INDOOR AIR 231-245 (2015).

[13] Brett Singer, Lawrence Berkeley National Lab, Sept. 30, 2020 Presentation Slides 6–8, available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=235047&DocumentContentId=67939

[14] U.S. EPA. Integrated Science Assessment (ISA) For Oxides of Nitrogen – Health Criteria (Final Report, 2016). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-15/068, 2016

[15] Hansel NN, Breysse PN, McCormack MC, et al. A longitudinal study of indoor nitrogen dioxide levels and respiratory symptoms in inner-city children with asthma. *Environmental Health Perspectives.* 2008;116(10):1428-1432.

[16] W. Lin, B. Brunekreef, and U. Gehring, "Meta-Analysis of the Effects of Indoor Nitrogen Dioxide and Gas Cooking on Asthma and Wheeze in Children," *International Journal of Epidemiology* 42, no. 6 (August 20, 2013): 1724–37, https://doi.org/10.1093/ije/dyt150.

[17] Kathleen Belanger et al., "Household Levels of Nitrogen Dioxide and Pediatric Asthma Severity," *Epidemiology* 24, no. 2 (March 2013): 320–30, https://doi.org/10.1097/ede.0b013e318280e2ac.

[18] Downen S R, Dong Q, Chorvinsky E, et al. Personal NO2 sensor demonstrates feasibility of in-home exposure measurements for pediatric asthma research and management. *J Expo Sci Environ Epidemiol*. 2022;32(2):312-319, https://www.nature.com/articles/s41370-022-00413-0.

[19] U.S. EPA. Integrated Science Assessment (ISA) For Oxides of Nitrogen – Health Criteria (Final Report, 2016). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-15/068, 2016

respiratory effects. Additionally, the EPA finds that long-term exposure to NO_2 is likely to have a causal relationship with respiratory effects[20].

Table ES-1 Causal determinations for relationships between nitrogen dioxide exposure and health effects from the 2008 and 2016 Integrated Science Assessment for Oxides of Nitrogen.

Exposure Duration and Health Effects Category[a]	Causal Determination[b]	
	2008 Integrated Science Assessment	2016 Integrated Science Assessment
Short-Term Nitrogen Dioxide Exposure (minutes up to 1 month)		
Respiratory effects Section 5.2, Table 5-39	Sufficient to infer a likely causal relationship	Causal relationship
Cardiovascular effects Section 5.3, Table 5-52	Inadequate to infer the presence or absence of a causal relationship	Suggestive of, but not sufficient to infer, a causal relationship
Total mortality Section 5.4, Table 5-57	Suggestive of, but not sufficient to infer, a causal relationship	Suggestive of, but not sufficient to infer, a causal relationship
Long-Term Nitrogen Dioxide Exposure (more than 1 month to years)		
Respiratory effects Section 6.2, Table 6-5	Suggestive of, but not sufficient to infer, a causal relationship	Likely to be a causal relationship
Cardiovascular effects and diabetes[c] Section 6.3, Table 6-11	Inadequate to infer the presence or absence of a causal relationship	Suggestive of, but not sufficient to infer, a causal relationship
Reproductive and developmental effects[c] Sections 6.4.2, 6.4.3, and 6.4.4, Table 6-14	Inadequate to infer the presence or absence of a causal relationship	Fertility, reproduction, and pregnancy: Inadequate to infer a causal relationship
		Birth outcomes: Suggestive of, but not sufficient to infer, a causal relationship
		Postnatal development: Inadequate to infer a causal relationship
Total mortality Section 6.5, Table 6-18	Inadequate to infer the presence or absence of a causal relationship	Suggestive of, but not sufficient to infer, a causal relationship
Cancer Section 6.6, Table 6-20	Inadequate to infer the presence or absence of a causal relationship	Suggestive of, but not sufficient to infer, a causal relationship

More recently than EPA's 2016 Integrated Science Assessment, RMI and partners conducted an extensive literature review on the topic of the health effects from gas stove pollution, which was published in May 2020.[21] To provide the most current analysis, RMI's report on the health impacts of gas stove pollution focused on the most recent 20 years of research (2000 – 2020). That report contains extensive references to peer-reviewed literature detailing the strong and ever-growing scientific consensus on the respiratory harm from gas stove emissions, especially for children.

One of the leading medical associations in the U.S., the American Medical Association, passed a resolution in 2022 recognizing the association between gas stoves, indoor NO_2 concentrations, and

[20] U.S. EPA. Integrated Science Assessment (ISA) For Oxides of Nitrogen – Health Criteria (Final Report, 2016). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-15/068, 2016.

[21] Brady Seals and Andee Krasner, Health Effects from Gas Stove Pollution, Rocky Mountain Institute, Physicians for Social Responsibility, Mothers Out Front, and Sierra Club, 2020, https://rmi.org/insight/gasstoves- pollution-health.

pediatric asthma.[22] A 2021 Washington State Medical Association policy statement echoes this sentiment, declaring that "gas for cooking represents a health hazard."[23]

Peer-reviewed science unequivocally links gas stoves and negative health impacts. Any claims of the contrary are misinformed, misguided, and misleading.

3) The Health Evidence Cannot Be Ignored in the Building Code Process

The gas industry often attempts to cast doubt on research establishing a clear link between gas stoves and health effects – but these attempts fall flat.

For example, on September 20, 2022, at the SBCC Public Hearing, a Northwest Gas Association representative claimed that there is no science indicating that gas stoves are particularly dangerous, that the health risks are primarily from cooking without ventilation, and that no longitudinal peer reviewed study shows a causal link between gas cooking and asthma.[24] Another tactic used by the Northwest Gas Association representative was to selectively a single study by Wong et al. that did not find an association between gas cooking and asthma. However, as indicated in Points 1 and 2, a robust set of studies offer evidence that there is an association between gas cooking and asthma plus other health effects. Northwest Gas Association is not alone in trying to cast doubt on the connection between gas cooking and health impacts. During the same SBCC Hearing, a representative from the Building Industry Association of Washington also made similar remarks.[25]

Wong et al. is a single study that did not find an association between gas cooking and asthma.[26] This study is based on a self-reported global survey in which the respondents were children aged 13-14 and parents of kids aged 6-7.[27] A main factor that could mask an association between gas cooking and asthma is that Wong et al. combined 31 countries in the study. By combining data from 31 countries, the differences across countries in housing characteristics, ambient temperatures, and ventilation may mask the association between gas cooking and asthma. Additionally, without better isolation between geographies and types of housing and associated ventilation, it is problematic to assume the global

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[22] American Medical Association. Resolution 439 – Informing Physicians, Health Care Providers, and the Public That Cooking with a Gas Stove Increases Household Air Pollution and the Risk of Childhood Asthma. 2022. https://www.ama-assn.org/system/files/a22-refcmte-d-report-annotated.pdf.

[23] Washington State Medical Association. Promotion of Building Electrification to Improve Human Health. 2021. https://wsma.org/WSMA/WSMA/About/Policies/Whats_Our_Policy/Public_Health/promotion_of_building_electrification_to_improve_human_health.aspx.

[24] Washington State Building Code Council, Public Hearing on September 20, 2022 (starting at minute 18), https://youtu.be/B0_iguI2h_k.

[25] Washington State Building Code Council, Public Hearing on September 20, 2022 (starting at minute 35), https://youtu.be/B0_iguI2h_k.

[26] Gary WK Wong et al., "Cooking Fuels and Prevalence of Asthma: A Global Analysis of Phase Three of the International Study of Asthma and Allergies in Childhood (ISAAC)," *The Lancet Respiratory Medicine* 1, no. 5 (July 2013): 386–94, https://doi.org/10.1016/s2213-2600(13)70073-0.

[27] Gary WK Wong et al., "Cooking Fuels and Prevalence of Asthma: A Global Analysis of Phase Three of the International Study of Asthma and Allergies in Childhood (ISAAC)," *The Lancet Respiratory Medicine* 1, no. 5 (July 2013): 386–94, https://doi.org/10.1016/s2213-2600(13)70073-0.

findings are applicable to California or the United States.[28] In short, one cross-sectional study not specific to the U.S. does not call into question an entire body of scientific literature that has established a clear relationship between gas stoves and respiratory health effects.

The cited study by Wong et al. is not based on measured concentrations of NO_2 in the home – it was based on survey data alone. When analyzing existing literature, it is extremely important to include studies that have measured concentrations of NO_2. Such as in the Belanger et al 2013 study mentioned above.[29] Further, in an E&E News (acquired by Politico) article in 2022,[30] one of the Wong et al. co-authors – Dr. Bert Brunekreef, an emeritus professor of environmental epidemiology at Utrecht University in the Netherlands —said that this research was based on "a short, self-administered questionnaire" on the presence of cooking appliances." Dr. Bert Brunekreef is also a co-author on the Lin et al. meta-analysis that found that gas cooking increased the risk of asthma in children.[31] Because the Lin et al. meta-analysis combined detailed evidence on indoor NO_2 from many studies, he stated it is "more valid that just the presence or absence of a gas cooker" and it "should carry more weight" than Wong et al.

4) There is Precedent for Strengthening Ventilation Requirements Based on Health and Science

The California Energy Commission (CEC) enacted differentiated range hood requirements for gas stoves vs. electric stoves as part of the Title 24 process. These requirements are included in the final 2022 version of Title 24, Part 6, which will go into effect in January 2023.[32] The new California building codes are based on science, including simulations and tests done by Lawrence Berkeley National Laboratory (LBNL) and compared to health-based guidelines. Tests show that the primary pollutant from electric stoves is $PM_{2.5}$ whereas the primary pollutant from gas stoves in NO_2.[33] Results from the Monte Carlo

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[28] For example, the study does not control for ventilation or ambient temperature (i.e., living in warmer climates where windows may be open can lead to decreased emissions concentrations and affect personal exposure). A study from Lawrence Berkeley National Laboratory, particular to the California climate, clearly shows that NO_2 levels are highest in the winter when windows are closed. Jennifer M. Logue et al., "Pollutant Exposures from Natural Gas Cooking Burners: A Simulation-Based Assessment for Southern California," www.osti.gov, June 1, 2014, https://www.osti.gov/servlets/purl/1163745.

[29] Kathleen Belanger et al., "Household Levels of Nitrogen Dioxide and Pediatric Asthma Severity," *Epidemiology* 24, no. 2 (March 2013): 320–30, https://doi.org/10.1097/ede.0b013e318280e2ac.

[30] D. Iaconangelo. Report: Gas stove emissions are dangerous, need federal regs. 2022. E&E News, https://subscriber.politicopro.com/article/eenews/2022/04/25/report-gas-stove-emissions-are-dangerous-need-federal-regs-00024690?utm_campaign=Hot%20News&utm_medium=email&_hsmi=211136778&_hsenc=p2ANqtz-9zj_mDnXrlJvsYDKAqPsoX8Mdx_EpDUHdMlEduff2Ok-rt6a6wcNT5GJ8KJTe-ycvqDJSjeuTDtdFGBPbw3P_5gzzJ4A&utm_content=211136778&utm_source=hs_email

[31] W. Lin, B. Brunekreef, and U. Gehring, "Meta-Analysis of the Effects of Indoor Nitrogen Dioxide and Gas Cooking on Asthma and Wheeze in Children," *International Journal of Epidemiology* 42, no. 6 (August 20, 2013): 1724–37, https://doi.org/10.1093/ije/dyt150.

[32] https://www.energy.ca.gov/sites/default/files/2022-08/CEC-400-2022-010_CMF.pdf

[33] W. Chan, K. Sangeetha, A. Johnson, and B.C. Singer, "Simulations of Short-Term Exposure to NO2 and PM2.5 to Inform Capture Efficiency Standards," *LBNL*, (2020). https://eta-publications.lbl.gov/sites/default/files/lbnl_report_simulations_of_short-term_exposure_to_no2_and_pm2.5_to_inform_capture_efficiency_standards.pdf.

simulations done by LBNL show that a higher capture efficiency and airflow is required for range hoods over gas stoves, especially for smaller unit sizes since there is less dilution of the pollutants.[34]

The ventilation proposals under consideration (21-GP2-062 and 21-GP2-063), gives great design flexibility by allowing for range hoods to either comply with the capture efficiency requirements or air flow rates needed to exhaust the pollutants to safe and healthy levels. All range hoods can comply by either pathway, so adding the capture efficiency option increases flexibility for the code, which should expand the available products and potentially lower costs.

Health must be considered in the 2021 Building Code

Ensuring that Washingtonians are able to breathe clean air inside our buildings is crucial to our well-being. Northwest Gas Association and allies have attempted to cast doubt on the research linking gas stoves and health effects, dangerously misrepresenting the current scientific understanding of public health threats. The scientific evidence is clear that unlike electric appliances, gas appliances in buildings are uniquely responsible for poor air quality and its associated health impacts. Health risks from indoor air pollution are not adequately addressed by current regulation. Implementing more rigorous policies that reduce household gas stove pollution will help Washington reduce the risk of childhood asthma, asthma symptoms, and asthma-related emergency department visits. The time is right for the Washington State Building Codes Council to take strong action in protecting the health of all Washingtonians. We urge the Washington State Building Codes Council to pass proposals 21-GP2-062 and 21-GP2-063 into the 2021 building code.

Respectfully submitted,

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[34] M. Nakajima, M. Goebes, E. McCollum (TRC) to CEC Staff, "Market Analysis in Support of Single-family and Updated Multifamily Range-Hood Requirements", *Letter to CEC docket* (December 30, 2020): https://efiling.energy.ca.gov/getdocument.aspx?tn=236201.